Application Serial No. 09/785,717

IN THE CLAIMS

1. (currently amended): ~~Apparatus~~ A transmitter for use in an Orthogonal Frequency Division Multiplexing (OFDM) based transmission system, the transmitter comprising:

a differential encoder that generates a corresponding encoded output symbol from a corresponding input symbol to said transmitter, said differential encoder including a multiplier for multiplying said input symbol with a prescribed previous output symbol from said differential encoder so that the phase values of said input symbol and said prescribed previous output symbol are the same;

an inverse fast Fourier transform unit that generates inverse fast Fourier transform versions of output symbols from said differential encoder; and

an inverse discrete Fourier transform unit that generates inverse discrete Fourier transform versions of said inverse fast Fourier transform versions of said differential encoder output symbols as ~~transmit~~ transmitter output data symbols,

~~whereby~~ wherein phase values of said ~~transmit~~ transmitter output data symbols are not required to be transmitted to a remote receiver for said receiver to generate received versions of said input symbols corresponding to said ~~transmit~~ transmitter output data symbols.

2. (currently amended): The ~~apparatus~~ transmitter as defined in claim 1 wherein said prescribed previous output symbol from said differential encoder is a V^{th} previous differential encoder output symbol, where $V > 1$.

3. (currently amended): The ~~apparatus~~ transmitter as defined in claim 2 wherein said inverse fast Fourier transform unit employs a prescribed phase sequence $\{\theta_{n,k}\}$ ~~is used~~ to generate said inverse fast Fourier transform versions, ~~where~~ wherein said prescribed phase sequence $\{\theta_{n,k}\}$ is periodic in n, with period V and n is the n^{th} sub-carrier in ~~the~~ a k^{th} OFDM symbol.

4. (currently amended): The ~~apparatus~~ transmitter as defined in claim 3 wherein said differential encoder is supplied with input data symbol $C_{n,k}$ and generates output data symbol $D^{V}_{n,k}$, in accordance with $D^{V}_{n,k} = C_{n,k} D^{V}_{n-V,k}$.

5. (currently amended): The ~~apparatus~~ transmitter as defined in claim 4 wherein said inverse fast Fourier transform unit includes a multiplier to generate said inverse fast Fourier transform versions $E_{n,k}$ by multiplying said output data symbols $D^V_{n,k}$ with $e^{j\theta_{n,k}}$, in accordance with $E_{n,k} = e^{j\theta_{n,k}} D^V_{n,k}$, for $n = 0, 1, \ldots, (N\text{-}1)$ and where N is ~~the~~ a number of OFDM sub-carriers employed in said OFDM based transmission system.

6. (currently amended): The ~~apparatus~~ transmitter as defined in claim 5 wherein said inverse discrete Fourier transform unit is supplied with said inverse fast Fourier transform versions $E_{n,k}$ to generate said inverse discrete Fourier transform versions $e_{m,k}$, in accordance with $e_{m,k} = \sum E_{n,k} e^{-j\frac{2\pi}{N}nm}$, for $m = 0, 1, \ldots, (N\text{-}1)$.

7. (currently amended): The ~~apparatus~~ transmitter as defined in claim 6 wherein OFDM symbols to be transmitted for said encoder output data symbols $D^V_{n,k}$ ~~is~~ are

$$s^V{}_k(t) = \begin{cases} \frac{1}{\sqrt{T_s}} \sum_{n=0}^{N-1} e^{j\theta_{n,k}} D^V{}_{n,k} e^{j2\pi\frac{n}{T_s}t} & t \in [kT_0, (k+1)T_0] \\ 0 & otherwise \end{cases},$$

where T_0 is the effective transmit duration of an OFDM symbol and T_s is the OFDM symbol interval.

8. (currently amended): The ~~apparatus~~ transmitter as defined in claim 4 wherein said differential encoder is a differential phase shift keying (DPSK) encoder.

9. (currently amended): The ~~apparatus~~ transmitter as defined in claim 1 further including a transmit output control responsive to a control signal for controlling transmission of OFDM symbols, a phase sequence selection processor supplied with said inverse discrete Fourier transform versions for generating said control signal to enable transmission of an OFDM symbol in accordance with prescribed criteria.

10. (currently amended): The ~~apparatus~~ transmitter as defined in claim 9 wherein said prescribed criteria includes making a first determination of whether a value of a prescribed relationship of a sequence of said inverse discrete Fourier transform versions $\{e_{m,k}\}$, for $m = 0, 1, \ldots, (N\text{-}1)$, where N is a number of OFDM sub-carriers and k is ~~the~~ a k^{th} OFDM symbol, is at least less than a predetermined threshold value, and when said

value of said prescribed relationship is determined to be at least less than said predetermined threshold, generating said control signal to enable transmission of a corresponding OFDM symbol.

11. (currently amended): The ~~apparatus~~ transmitter as defined in claim 10 wherein said prescribed previous output symbol from said differential encoder is a V^{th} previous output symbol, where $V > 1$ and said inverse fast Fourier transform unit employs a prescribed phase sequence $\{\theta_{n,k}\}$ to generate said inverse fast Fourier transform versions, where said prescribed phase sequence $\{\theta_{n,k}\}$ is periodic in n with period V and n is the n^{th} sub-carrier in the k^{th} OFDM symbol, and wherein said prescribed criteria further includes when said determination indicates that said value of said prescribed relationship of said inverse discrete Fourier transform versions $\{e_{m,k}\}$ is not less than said predetermined threshold value, selecting a new phase sequence $\{\theta_{n,k}\}$ to generate new versions of said inverse fast Fourier transform $E_{n,k}$ for $n = 0, 1, \ldots, (N\text{-}1)$, where N is a number of OFDM sub-carriers and said sequence of discrete Fourier transform versions $\{e_{m,k}\}$.

12. (currently amended): The ~~apparatus~~ transmitter as defined in claim 11 wherein said prescribed criteria further includes when said determination indicates that said value of said prescribed relationship of said sequence of said new inverse discrete Fourier transform versions $\{e_{m,k}\}$ is at least less than said predetermined threshold value, generating said control signal to enable transmission of a corresponding OFDM symbol and, if not, selecting a new phase sequence and repeat generating a new sequence $\{e_{m,k}\}$ and making said first determination until said value of said prescribed relationship is at least less than said predetermined threshold value or a predetermined number of recomputations of said sequence $\{e_{m,k}\}$ is reached, and when said determination indicates that said value of said prescribed relationship of said sequence of said new inverse discrete Fourier transform versions $\{e_{m,k}\}$ is not at least less than said predetermined threshold value and said predetermined number of recomputations has been reached select the phase sequence $\{\theta_{n,k}\}$ that generated the smallest value for said prescribed

relationship and generate said control signal to enable transmission of a OFDM symbol corresponding to said phase sequence that caused the smallest value for said prescribed relationship to be generated.

13. (currently amended): The ~~apparatus~~ transmitter as defined in claim 13 wherein said prescribed relationship is $\sum_{m=0}^{N-1} \left| e_{m,k} \right|^2$, for $m = 0, 1, \ldots, (N\text{-}1)$.

14. (currently amended): ~~Apparatus~~ A transmitter for use in an Orthogonal Frequency Division Multiplexing (OFDM) based transmission system, the transmitter comprising:

means for differentially encoding a input symbol to said transmitter to generate a corresponding differentially encoded output symbol, said means for differentially encoding including means for multiplying said transmitter input symbol with a prescribed encoded output symbol so that the phase values of said input symbol and said prescribed previous output symbol are the same;

means for generating inverse fast Fourier transform versions of said differentially encoded output symbols from said means for differentially encoding; and

means for generating inverse discrete Fourier transform versions of said inverse fast Fourier transform versions of said encoded output symbols as ~~transmit~~ transmitter output data symbols,

~~whereby~~ wherein phase values of said transmit data symbols are not required to be transmitted to a remote receiver for said receiver to generate received versions of said input symbols corresponding to said ~~transmit~~ transmitter output data symbols.

15. (currently amended): The ~~apparatus~~ transmitter as defined in claim 14 wherein said prescribed differentially encoded output symbol is a V^{th} previous differentially encoded output symbol, where $V > 1$.

16. (currently amended): The ~~apparatus~~ transmitter as defined in claim 15 wherein said means for generating said inverse fast Fourier transform versions includes means for multiplying said encoded output symbols with a prescribed relationship of a prescribed phase sequence $\{\theta_{n,k}\}$ to generate said inverse fast Fourier transform versions, where said

prescribed phase sequence $\{\theta_{n,k}\}$ is periodic in n, with period V and n is ~~the~~ a n^{th} sub-carrier in ~~the~~ a k^{th} OFDM symbol.

17. (currently amended): A method for use in a transmitter of an Orthogonal Frequency Division Multiplexing (OFDM) based transmission system, the method in said transmitter comprising the steps of:

differentially encoding an input symbol said transmitter to generate a corresponding differentially encoded output symbol, said step of differentially encoding including a step of multiplying said input symbol with a prescribed differentially encoded output symbol so that the phase values of said transmitter input symbol and said prescribed previous differentially encoded output symbol are the same;

inverse fast Fourier transforming to generate inverse fast Fourier transform versions of output symbols from said differential encoder; and

inverse discrete Fourier transforming to generate inverse discrete Fourier transform versions of said inverse fast Fourier transform versions as ~~transmit~~ transmitter output data symbols,

~~whereby~~ wherein phase values of said ~~transmit~~ transmitter output data symbols are not required to be transmitted to a remote receiver for said receiver to generate received versions of said input symbols corresponding to said ~~transmit~~ transmitter output data symbols.

18. (currently amended): The method as defined in claim 17 wherein said prescribed differentially encoded output symbol is a V^{th} previous differentially encoded output symbol, where $V > 1$.

19. (currently amended): The method as defined in claim 18 wherein said step of inverse fast Fourier transforming includes a step of utilizing a prescribed phase sequence $\{\theta_{n,k}\}$ to generate said inverse fast Fourier transform versions, where said prescribed phase sequence $\{\theta_{n,k}\}$ is periodic in n, with period V and n is ~~the~~ a n^{th} sub-carrier in ~~the~~ a k^{th} OFDM symbol.

20. (currently amended): The method as defined in claim 19 wherein said step of differentially encoding is supplied with transmitter input symbol $C_{n,k}$ and generates differentially encoded output data symbol $D^{V}_{n,k}$, in accordance with $D^{V}_{n,k} = C_{n,k} D^{V}_{n-V,k}$.

21. (currently amended): The method as defined in claim 20 wherein said step of inverse fast Fourier transforming includes a step of multiplying said differentially encoded output data symbols $D^{V}_{n,k}$ with $e^{j\theta_{n,k}}$ to generate said inverse fast Fourier transform versions $E_{n,k}$, in accordance with $E_{n,k} = e^{j\theta_{n,k}} D^{V}_{n,k}$, for n = 0, 1, …, (N-1), where N is ~~the~~ a number of OFDM sub-carriers employed in said OFDM based transmission system.

22. (original): The method as defined in claim 21 wherein said step of inverse discrete Fourier transforming includes a step of generating said inverse discrete Fourier transform versions $e_{m,k}$, in accordance with $e_{m,k} = \sum E_{n,k} e^{j\frac{2\pi}{N}nm}$, for m = 0, 1, …, (N-1), in response to said inverse fast Fourier transform versions $E_{n,k}$.

23. (currently amended): The method as defined in claim 22 wherein OFDM symbols to be transmitted for said differentially encoded output data symbols $D^{V}_{n,k}$ is

$$s^{V}{}_{k}(t) = \begin{cases} \frac{1}{\sqrt{T_s}} \sum_{n=0}^{N-1} e^{j\theta_{n,k}} D^{V}{}_{n,k} e^{j2\pi \frac{n}{T_s} t} & t \in [kT_0, (k+1)T_0] \\ 0 & otherwise \end{cases},$$

where T_0 is the effective transmit duration of an OFDM symbol and T_s is the OFDM symbol interval.

24. (currently amended): The method as defined in claim 20 wherein said step of differentially encoding utilizes differential phase shift keying (DPSK) encoding.

25. (original): The method as defined in claim 17 further including a step of controlling transmission of OFDM symbols in response to a control signal, a step of selecting a phase sequence in response to said inverse discrete Fourier transform versions to generate said control signal to enable transmission of an OFDM symbol in accordance with prescribed criteria.

26. (currently amended): The method as defined in claim 25 wherein said prescribed criteria includes a first step of determining whether a value of a prescribed relationship of a sequence of said inverse discrete Fourier transform versions $\{e_{m,k}\}$, for $m = 0, 1, \ldots, (N-1)$, where N is a number of OFDM sub-carriers and k is ~~the~~ a k^{th} OFDM symbol, is at least less than a predetermined threshold value, and when said first step of determining indicates that said value of said prescribed relationship is at least less than said predetermined threshold, generating said control signal to enable transmission of a corresponding OFDM symbol.

27. (currently amended): The method as defined in claim 26 wherein said prescribed differentially encoded output symbol is a V^{th} previous differentially encoded output symbol, where $V > 1$ and said step of inverse fast Fourier transforming includes a step of utilizing a prescribed phase sequence $\{\theta_{n,k}\}$ to generate said inverse fast Fourier transform versions, where said prescribed phase sequence $\{\theta_{n,k}\}$ is periodic in n with period V and n is the n^{th} sub-carrier in the k^{th} OFDM symbol, and wherein said prescribed criteria further includes, if said value of said prescribed relationship of said inverse discrete Fourier transform versions $\{e_{m,k}\}$ is not less than said predetermined threshold value, a step of selecting a new phase sequence $\{\theta_{n,k}\}$ to generate new versions of said inverse fast Fourier transform $E_{n,k}$ for $n = 0, 1, \ldots, (N-1)$, where N is a number of OFDM sub-carriers and said sequence of discrete Fourier transform versions $\{e_{m,k}\}$.

28. (currently amended): The method as defined in claim 27 wherein said prescribed criteria further includes said first determining step determining whether a value of said prescribed relationship of said sequence of said new inverse discrete Fourier transform versions $\{e_{m,k}\}$ is at least less than said predetermined threshold value, when said step of determining indicates that said value of said prescribed relationship is at least less than said predetermined threshold, a step of generating said control signal to enable transmission of a corresponding OFDM ~~symbo,l~~ symbol and when said step of determining indicates that said value of said prescribed relationship is not at least less than said predetermined threshold, a step of selecting a new phase sequence and repeat generating a new sequence $\{e_{m,k}\}$ and repeating said step of first determining until said

value of said prescribed relationship is at least less than said predetermined threshold value or a predetermined number of recomputations of said sequence $\{e_{m,k}\}$ is reached, when said predetermined number of recomputations has been reached, a step of selecting the phase sequence $\{\theta_{n,k}\}$ that generated the smallest value for said prescribed relationship and a step of generating said control signal to enable transmission of a OFDM symbol corresponding to said phase sequence that caused the smallest value for said prescribed relationship to be generated.

29. (original): The method as defined in claim 28 wherein said prescribed relationship is

$$\sum_{m=0}^{N-1} \left|e_{m,k}\right|^2, \text{ for } m = 0, 1, \ldots, (N\text{-}1).$$

30. (currently amended): Apparatus for use in an Orthogonal Frequency Division Multiplexing (OFDM) based transmission system in which OFDM symbols are transmitted to a receiver, in accordance with

$$s^V{}_k(t) = \begin{cases} \frac{1}{\sqrt{T_s}} \sum_{n=0}^{N-1} e^{j\theta_{n,k}} D^V{}_{n,k} e^{j2\pi \frac{n}{T_s} t} & t \in [kT_0, (k+1)T_0] \\ 0 & otherwise \end{cases}$$

, where the phase sequence $\theta_{n,k}$ is periodic in n with period V and n is the n^{th} sub-carrier in the k^{th} OFDM symbol and $D^V_{n,k}$ is generated in a differential encoder where a current input data symbol to the encoder is multiplied by the V^{th} previous output data symbol from said encoder, the receiver including apparatus comprising:

a discrete Fourier transform unit that generates discrete Fourier transform versions of digital received versions of said transmitted OFDM data symbols; and

a differential decoder that generates a corresponding decoded output symbol from a corresponding Fourier transformed version of a received version of said transmitted OFDM data symbols, said decoder including a multiplier for multiplying said input symbol with a prescribed previous input symbol to generate a received OFDM data symbol,

whereby phase values of said transmit data symbols are not required to be transmitted to a remote receiver for said receiver to generate received versions of said input symbols corresponding to said transmit data symbols.

31. (original): The apparatus as defined in claim 30 wherein said prescribed previous output symbol from said encoder is a V^{th} previous encoder output symbol, where $V > 1$.

32. (original): The apparatus as defined in claim 31 wherein said discrete Fourier transform unit is supplied with digital versions of said received OFDM data symbols and generates discrete Fourier transforms versions of said received OFDM data symbols in accordance with $R_{n,k} = e^{j\theta_{n,k}} D_{n,k}^{V}$, for $n = 0,1, \ldots, (N-1)$.

33. (original): The apparatus as defined in claim 32 wherein said differential decoder is supplied with said discrete Fourier transformed versions of said received OFDM data symbols and generates received versions of said transmitted OFDM data symbols in accordance with $\hat{C}_{n,k} = R_{n,k} R_{n-V,k}^{*}$, where "*" indicates the complex conjugate.

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